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ABSTRACT

The information-based technologies and the accompanying managerial sciences have come to symbolize the ideology of progress and operate as a material instrumentality in social governance systems. Developing countries have incorporated the technologies, but have lacked a developed knowledge or service sector; the linkage of knowledge-informatization-economic development has been incomplete. Social and institutional mechanisms to produce and utilize scientific and technological knowledge must be developed if this linkage is to be completed. This paper presents: (1) a model of technology and science policy in Argentina and Brazil which argues that anti-dependency scientific and intellectual elites form an epistemic community capable of intervening in national policy-making processes; (2) an alternative model for a national study of informatics technologies based on the Colombian experience which emphasizes the anchoring of informatics technology policy within concrete social conflicts, needs, and demands; (3) a conceptual model of the role of universities and research centers in the process of Colombia's informatization; and (4) an interpretation of the Colombian experience within the framework of compensatory legitimation and conflict management. It is concluded that informatics technologies play an important role within the political, economic, and social development of Latin American countries, but the extent to which these technologies are becoming tools for progress or instruments of control are yet to be determined. (35 references) (ALL)

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INFORMATICS SCIENCE AND TECHNOLOGY FOR DEVELOPMENT IN LATIN AMERICA: TOWARDS A CONCEPTUAL FRAMEWORK FOR COMPARATIVE ANALYSIS

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By

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INTRODUCTION

Scientific and technological change has become a driving force in the development of the modern world system and among nation states (Pecujlic, 1982; Ladriere, 1977). How the process of scientific and technological change is undertaken is therefore an important indicator of development directions. Moreover, within the broad domain of scientific and technological development, "information-based" technologies (computers, telecommunications and the managerial sciences attached) play a particularly important role. They are what Bolter[1] has termed the "defining technologies" of the age. They have come to symbolize the ideology of progress of the later part of the twentieth century. Technology has become a sort of "deus-ex-machina", presented as an innovation and a proof of "modernization" (Finlay, 1987).

They also operate as an important material instrumentality in social governance systems; they are the technology of "command and control" (Wiener, 1948). This is evident in their increasingly important role within the modern technocratic state and within the organization of advanced capitalist relations of production (Schiller, 1981; Mattelart, 1983; Antonelli, 1988)

While the informatics technologies have been developed within the context of a sophisticated scientific-technological complex in the advanced industrial countries, global convergences have permitted developing nations to incorporate the technologies, though not the underlying science, simultaneously. "Traditional societies" have almost unanimously lacked a developed so-called knowledge or service sector, which is associated with these

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1 "A defining technology develops links, metaphorical or otherwise, with a culture's science, philosophy or literature; it is always available to serve as a metaphor, example, model or symbol" (Bolter, 1984: 11)

technologies. For developing countries the linkage of knowledge-informatization-economic development has been incomplete.

Higher education and university-like research centers play an especially important role as one of the three key actors in the triangular relationships with government and industry characteristic of advanced scientific and technological development (Sabato/Botana, 1970). Yet there have been relatively few studies, to date, which have addressed the overall process of incorporation of information-based technologies within developing societies; and even fewer looking at the specific role of the University and research centers in development of an advanced knowledge sector.

This paper will develop four major points. First, I will briefly present a model developed on science and technology policy in Argentina and Brazil by Emanuel Adler. This theory argues that anti-dependency scientific and intellectual elites (forming an "epistemic community"[2]) are capable of intervening in the policy-making process, leading to the development of national capabilities for scientific and technological development. The strengths and weaknesses of Adler's approach will be evaluated. Second, I will propose a alternative framework for a national study of informatics technologies, based on the Colombian experience. This will draw upon the notion of "epistemic communities", but will emphasize the anchoring of informatics technology policy within concrete social, conflicts, needs and

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2 Adler has offered multiple definitions of an epistemic community: "a group of professionals, usually from several disciplines; , united by a belief in the objective merit of their work and by a commitment to translate this objective into public policy in the conviction that human welfare will be enhanced as a result; members share a common set of cause-effect suppositions, values, concepts and meanings"; "they use their scientific prestige to gain legitimacy and authority within the political system, and are confident in their ability to deal rationally with problems, and to utilize their scientific knowledge and authority for solving them"; "an epistemic community can therefore, be described as a functional, politically-driven, ideologically self-contained, and distinct cross-section of the 'scientific estate'" (Adler, 1990: 9)

demands. Third, I will briefly present a conceptual model of the central role which universities and research centers play within this process of "informatization of Colombian society", as a more specific topic for future research. Fourth, the Colombian experience will be interpreted, as one mode of analysis, within the framework of compensatory legitimation and conflict management. This offers an important departure point for developing a broader theory of the "political economy of knowledge" centering on the special role of advanced technologies in developing societies.

As a definitional note, it should be emphasized that when I speak of scientific and technological development I am referring to a series of capabilities that modern nation states are in the process of developing. These include the ability to sustain certain types of scientific and technological research; and to search out, select, successfully transfer and innovate in technology. These capabilities require the development of social and institutional mechanisms to produce and utilize scientific and technological knowledge. With regards to information-based technologies and processes I am referring to computer systems, telecommunications facilities, data banks, software. Other useful concepts include management information systems, integrated systems (the entire physical and logical system, as well as the organization of the project), and so-called "intelligent decision support systems". It should also be noted that these technologies are increasingly interacting with a broader sphere of electronic machines which permit processing of images, sounds and symbols of all types.

2. The Role of Intellectuals and Scientific Elites in the Policy-Making Process

Emanuel Adler (1987) developed a model to explain scientific and technological change in Brazil and Argentina based upon the what he calls the incorporation of an "ideology of progress"[3]. He defines the notion of a political ideology as "a collective understanding .....[which] becomes a part of a collective set of beliefs...permitting individuals... conscious of each other's roles, beliefs, expectations and purposes...[to] offer strategies for action or solutions to problems that can be used to change reality...thus ideology becomes a real blueprint for action" (Ibid. 16-17). This is the "ideology of material progress" which developing countries are actively pursuing , "not only as as modernization and technological development but as a matter of autonomy and equality as well. Liberation, cultural self-determination, development, science and technology: these are the core dimensions of the idea of progress in the Third World" (Ibid, 17-18).

Adler goes on to describe the ways in which a set of critically minded "intellectual" and scientific elites (he calls them "pragmatic subversive anti-dependency guerrillas") influence state policies, leading to the development of national scientific and technological capabilities. (see Figure 1 below).[4] His model helps to see the ways in which "progressive" elites have recognized and the very real national and international power structures (e.g., military leaders, industrialists, politicians, etc.) and have encountered mechanisms for negotiation of their projects for change. Adler also develops a series of other paradigms of interest, which will not be presented here, including: an

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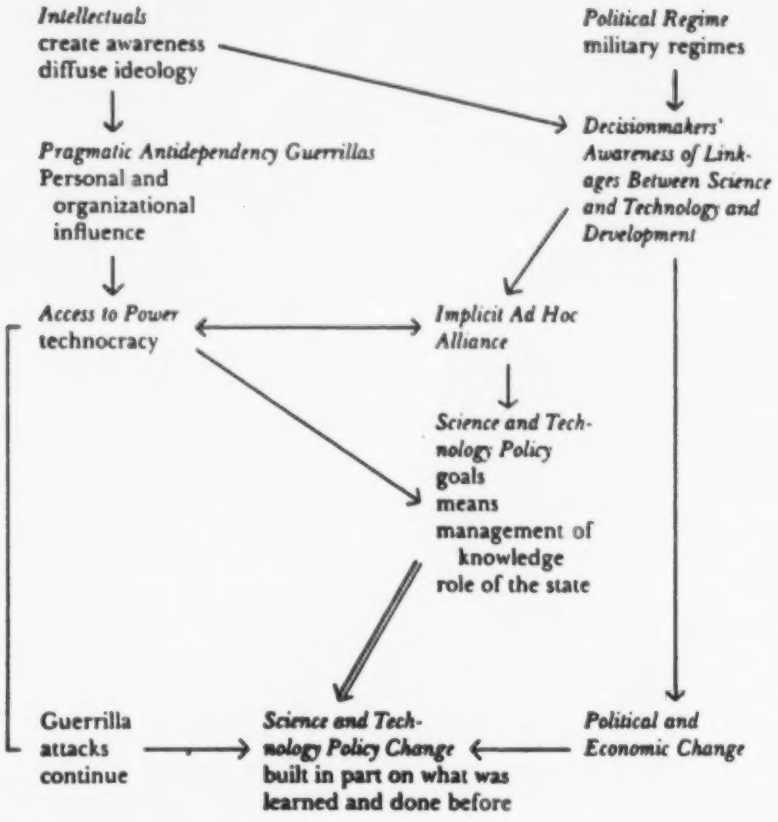
3 Though I have analyzed his work at much greater length, a detailed presentation is beyond the scope of this paper.

4 Adler (1990) goes on to further develop his theory of epistemic communities in a study of the evolution of the idea of international arms control.

Figure 1. Intellectuals and the Policy-Making Process



Saurce: Adler (1987)

alternative view of "The Modernization Process" (Ibid. 36), "Strategies for Managing Scientific and Technological Change" (Ibid. 64), and Journeys Toward Scientific and Technological Progress: A Theoretical Summary (Ibid. 330).

Adler' analysis has received praise on various accounts for providing "a fascinating set of case studies with a bold theoretical statement...[and for] having convinced us that ideology is important" (Evans, 1989: 311-312); by "help[ing] us to reorder our thinking with regard to the capacity of smart people to change the course of national policy, even given structures, situations and moments that seem inhospitable to bold innovation" (Dominguez, 1989: p. 375); by "counteracting the counsel of despair which implies that technological development is impossible in Latin America...(and by) provide(ing) a valuable insight into the process by which crucial decisions in this important field are made." (Jenkins, 1989: 171). Various fundamental weaknesses have also been suggested in Adler's approach, including: he maintains an "overly rigid separation between interest and ideology" (Mytelka, 1988); he has "adopted a highly voluntaristic approach, which suggests that if you only have the right individuals, the right ideology and requisite institutions things would be fine" (Jenkins, 1989); that potentially competing explanations have not been explored, including: "that patterns of economic growth explain much about the patterns of scientific and technological change...." or "their was a conditioning role of international factors particularly at the industry level (Jenkins, 1989). Also, "domestic politics is neglected as an explanation" (Dominguez, 1989) as well as "domestic class struggles" (Jenkins, 1989).[5] He also tends to "overemphasize the degree

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[5] For example, I would argue that the emergence of an embryonic, but important , tendency in Colombia toward a policy for scientific and technological development, is

of technological autonomy achieved by the industry" (Jenkins, 1989) as well as what benefits this technological autonomy has or has not provided towards the broader goals of national development.

2. Informatization of Colombian Society: An Alternative Model for Analysis

I am proposing an alternative model which although it utilizes some of the elements of the epistemic community approach, differs in significant ways. It places greater emphasis upon the driving force of world systems as explanatory components, both as regards scientific and technological change and international economics; it is oriented more at explaining systematically the underlying interests (or matrix) of social forces (military, political, economic, and social) and their linkages with the epistemic community (Adler see's the epistemic community as more independent than I believe it is); more emphasis is given to the relationships between informatization, the process of technocratization and the overall strategy of national development. Finally, I am interested in developing conceptual models which eventually allow for cross-country analysis along the full continuum of nations, from the most-advanced to the least advanced developing nations. Colombia as presented below is seen as a preliminary test case. Future research might, in addition to developing the Colombian case, attempt to compare such an approach between at least two middle-range developing countries

A Proposed Model for Comparative Analysis: Based on a Proto-Typical Colombian test Case

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closely associated to a series of domestic political needs, as well as the emergence of "epistemic communities".

The model is built upon the premise that it is crucial to see science and technology within a cross-sectoral framework (i.e., as a totality). Information-based technologies are particularly appropriate for such a cross-sectoral study because they are inter-related transversal instruments which cut across all sectors and institutions within society . Moreover, they play a strategic role in the creation and maintenance of governance and control systems.

Colombia offers various advantages as a test case. First, it has some important similarities and differences with the Brazilian and Argentinian cases. It's similarities are that: it is has a modified version of the doctrine of national security; it is large and dispersed (though on a much smaller scale); there is a growing and significant community of users of advanced technologies; its economic doctrine is undergoing major modifications; there are significant plans emerging for investments in scientific and technological development. It's differences are: it is a type B country according to World Bank standards; i.e., it is a middle range country in income, size and in industrial development; it was colonized by the Spanish as opposed to the Portuguese; it does not have at this time a computer assembly or production industry.

Second, Colombia is facing a socio-economic-political crisis of vast proportions, which is leading it into making major strategic policy changes towards the future. These include a potential opening up of the national economy to international competition (to date semi-closed under remaining import-substitution laws); a massive political, economic and administrative

decentralization process[6]; and an opening up of the political system to participation of alternative parties.

Third, the process of state technocratization, the development of a more advanced industrial economy and the technification of agriculture is bringing about a large scale incorporation of informatics-based technologies. These processes provide sufficient elements to carry out a cross-sectoral analysis.

I will now present two conceptual models to analyze the informatics technology policy-making process in general and subsequently briefly illustrate them with a few key elements of the actual Colombian test case as observed to date. The purpose of Figure 2 is to demonstrate the way in which empirically observable societal demands (level 1) lead to strategies for change (level 2) which are embodied within socio-political actors (level 3) These actors operating as a loose network represent an epistemic community who share the notion of an "ideology of progress". That is, they are struggling in diverse ways for policies and programs to transform a semi-feudal society into a more "modern", scientific and technologically advanced nation. This involves strengthening national capabilities in order to interact more "equally" in an interdependent world economy and polity. Fundamentally, what is argued is that the emergence of this epistemic community is anchored in real, concrete social conflicts, needs and demands (pressures), which can generate specific policy responses by the actors.

Figure 3 translates the underlying interests described in Figure 2, into a more detailed "Cross-Sectorial Framework for Science and Technology Policy". Each of the primary interest sectors have a set of fundamental

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6 Curiously enough, the decentralization process undertaken to date does not involve a large scale effort at decentralizing education. Might it be that because of the crucial role that education plays in inculcating values and in allocating status (Weiler, 1983), that this is seen as to risky a proposition for maintaining control?

FIGURE 2
EMERGENCE OF EPISTEMIC COMMUNITIES AND
A RESULTING SCIENCE AND TECHNOLOGY POLICY IN A TEST CASE

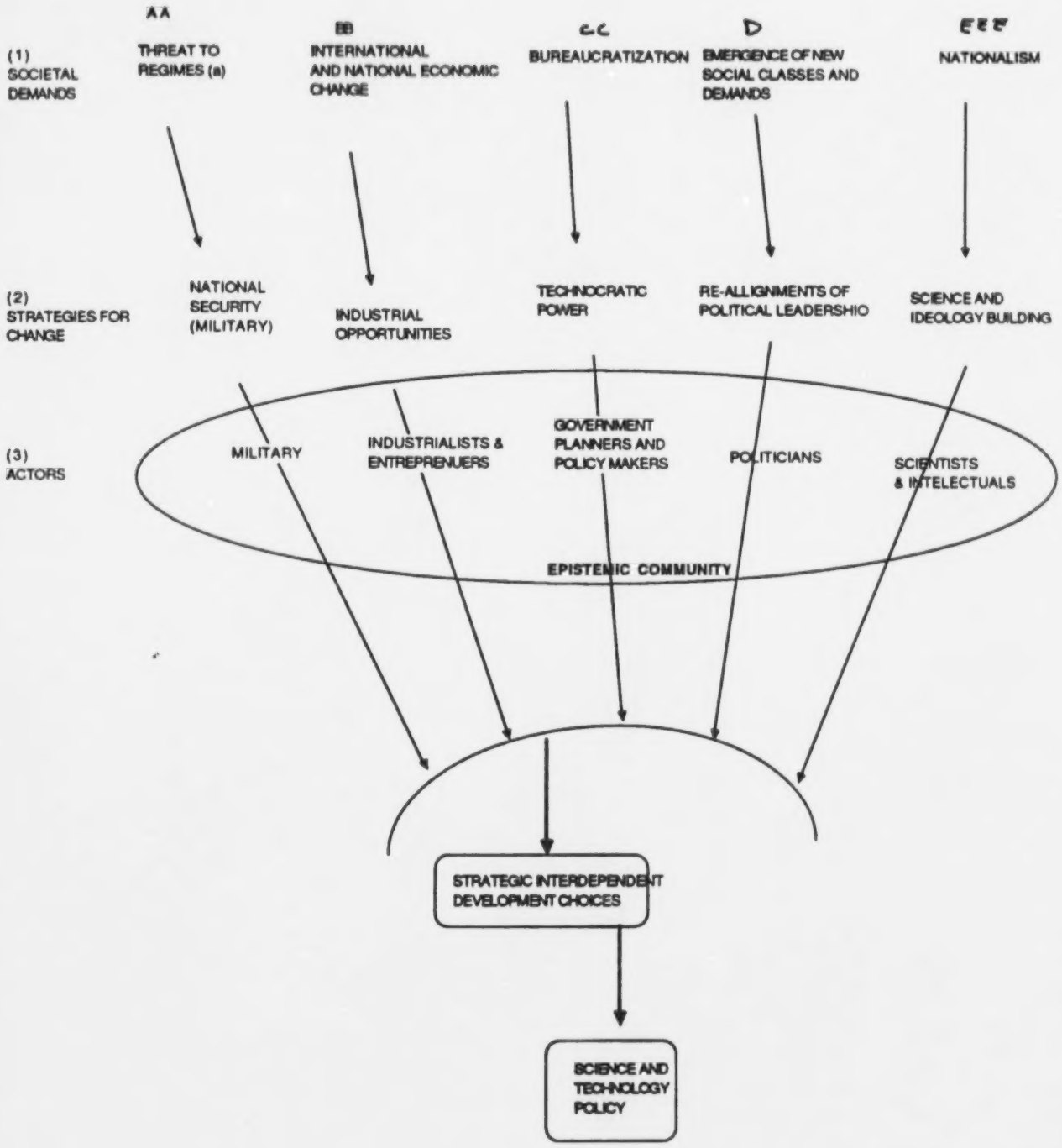

FIGURE 3
CROSS-SECTORIAL FRAMEWOK FOR
SCIENCE AND TECHNOLOGY POLICY:
INFORMATICS AND TELEMATICS TEST CASE"

		AA MILITARY	BB INDUSTRIAL	CC STATE	F LABOR	SCIENTIFIC RESEARCH	IDEOLOGICAL SUPERSTRUCTURE
CONCEPTUAL MODEL	STRATEGIC ROLE SOCIO-POLITICAL NEED	MILITARY CONTROL	PRIVATE ACCUMULATION	TECHNOCRATIC ADMINISTRATION	WORKFORCE	ADAPTATION AND INNOVATION	IDEOLOGICAL FOUNDATION
	POLICY TYPE	INFRASTRUCTURE	INDUSTRIAL POLICY	INFORMATION SYSTEMS AND MANAGERIAL METHODS	EDUCATION	RESEARCH AND DEVELOPMENT	SCIENTIFIC AND TECHNOLOGICAL ATTITUDES/ DISPOSITIONS
	TECHNOLOGY/ PROCESS TYPE	TELECOMMUNICATION	AUTOMATION	INFORMATION SYSTEMS & UPGRADING MANAGEMENT AND PERSONNEL	TECHNICAL TRAINING	DATA BASES	SCIENTIFIC LEARNING AND INSTRUMENT
COLOMBIAN CASE	SECTORAL POLICIES	NATIONAL REHABILITATION PROGRAM (INTERGATION OF NATIONAL TERRITORIES; (COMMUNICATION NETWORKS)	OPENING UP OF THE NATIONAL ECONOMY; INDUSTRIAL TARGETING PROGRAMS	SYSTEMATIZATION OF PUBLIC ADMINISTRATION	EXPANSION OF HIGHER EDUCATION, ESPEC. TECH TRAINING	SCIENTIFIC AND TECHNOLOGICAL RESEARCH FUNDING	POPULARIZATION OF SCIENCE AND TECHNOLOGY
	PRIMARY NATIONAL ACTORS	NATIONAL PLANNING, TELECOMMUNICATIONS ENTERPRISES	SELECT POLITICAL LEADERS, NATIONAL INDUSTRIAL ASSOCIATIONS, PRIVATE ENTERPRISES	PRESIDENTIAL INFORMATICS SECRETARIAT NATIONAL STATISTICAL AGENCY NATIONAL SCIENCE FOUNDATION	PRIVATE AND SELECT PUBLIC UNIVERSITIES, TECHNICAL TRAINING INSTITUTES	NATIONAL SCIENCE FOUNDATIONS, NATIONAL UNIVERSITIES,	NATIONAL SCIENCE FOUNDATION, MASS MEDIA
	SUPPORTING INTERNATIONAL ACTORS	MNC'S W/SECTORIAL INTERESTS; WORLD BANK	WORLDWIDE INDUSTRIAL ASSOCIATIONS	MNC'S INTERNATIONAL ORGANIZATIONS FOREIG GOVERNMENTAL AID AGENCIES	WORLD CLASS UNIVERSITIES AND RESEARCH CENTERS IN ADVANCED COUNTRIES	REGIONAL FINANCING AGENCIES (BID, IADB)	MNC'S, INFORMATION BASED SERVICE COMPANIES

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strategic"social-political-economic needs", generating supporting polices which rely upon certain technologies and processes. In concrete terms, each of these policies are seen in Colombia through specific sectoral policies, largely stimulated by the state[7], which can be clearly identified with a set of primary national actors and a series of supporting international actors.

A synoptic look at each of these interacting forces as observed in Colombia should help to clarify the nature of the model. Some of the columns in Figure 2 parallel the columns in Figure 3, i.e., AA - Military, BB - Industry, CC - State, EEE- Science and Ideology. Column D in Figure 2, Political actors, has nor parallel in Figure 3; neither does column F in Figure 3, Labor, have a similar column in Figure 2.

Conceptual Framework and Preliminary Interpretation of Colombian Case

(AA) Military: * Conceptual: The threat (perceived or real) to regime stability is likely to generate a "national security" type response on the part of military leaders (Frank, 1981). In physically dispersed countries (e.g., Colombia, Indonesia, etc.), national security (as well as economic development) are important justifications for investing in a national telecommunications infrastructure. Distributed information systems rely upon such a network, and are utilized as important instruments for social control. * Applied: In Colombia, the current National Rehabilitation Program (PNR) is the center piece of government planning and public expenditures, within which approximately one billion dollars will be invested in telecommunications over a five to seven year period.

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[7] Many of these policies and programs currently exist as programs or projects with identifiable names, objectives, budgets, timetables, and intervening actors.

(BB) Industry: * Conceptual: National bourgeoisie industrialists, and the political leaders who share their interests and vision, are attempting to transform a semi-feudal country (Cardoso, 1979) to impose rules for capitalist development (Offe/Ronge, 1989). The growing competition (i.e., threat) and opportunities generated by global capitalism, require that interdependent nation states modernize their productive sectors. This is being carried out through some form of industrial policy, development of human resources, and improving the level of technology.

* Applied: In Colombia, national economic policies are tending toward an opening up of the national economy, a growing use of industrial policy, and the technological renovation of selected industries.

(CC) State Technocracy: * Conceptual: State apparatuses around the world have grown in partial response to the overload of demands placed upon them (Weiler, 1983), in spite of partial reversals through the growing trend of privatization. This has led to an great potential for technocratically derived power, represented in by the interests of an increasingly sophisticated and nationalistic body of governmental planners and policy-makers. This has involved an expansion of the tools of modern managerial science and especially information-based technologies.

* Applied: The Colombian state has grown rapidly over the last thirty years yet has increasingly found itself under attack. Major political, administrative and economic reforms are being undertaken to restructure the state, redefine its mission, and improve its effectiveness and efficiency. Programs for systematization of the public administration at all levels have grown rapidly in response to these demands (Hogeboom, 1989).

(EEE) Nationalism and Scientists/Intellectuals: * Conceptual: Worldwide scientific and technological development has led to both it's

universalization as well as it's particularization (Ladriere, 1977; DeGregori, 1985: 35-40). The struggle to conserve and construct national identities, has led to the emergence of increasingly vocal groups of scientists, intellectuals and policy-makers pursuing development of both a "national culture" of scientific development * Applied: In Colombia there is an expansion of the funding for national research and development, as well as campaigns for the "popularization of science and technology" and educational reforms to incorporate scientific and technical education.

(D) Social Demands and political leadership: * Applied: The Socio-political-economic crisis which Colombia is currently facing have created new demands for large-scale reform[8]. Political leaders have been forced to seek new alliances and promote wide-ranging reforms to respond to these demands, including: privatization, massive decentralization, political participation, urban and rural land reform, modernization of state institutions, and capitalistic development of industry. There is a growing emphasis upon global interdependence and the development of an export-oriented economy.

(F) Labor Force Development: * Conceptual: Industrial changes (see BB) generate demands for different labor force profiles. * Applied: In Colombia there has been an explosion of formal (SENA) and non-formal technical training institutes, efforts to reform the national vocational training institute, rapid expansion of university programs in technical areas.

These simultaneous horizontal interactions among diverse actors and issues constitute the underlying interest matrix which emerges through

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8 A recent Washington based human rights report talks today about what they are calling the "Central-Americanization of Colombia". The levels of violence have reached astronomic proportions, which have in turn generated protracted massive popular mass movements for reform; see reports from CINEP (Center for Popular Education and Research).

cooperation and competition into a selective epistemic community which pressures for policies and programs oriented towards progress.

The following section focuses upon the special role which higher education and specialized research centers are playing within these sectoral transformations.

3. THE ROLE OF HIGHER EDUCATION IN THE INFORMATIZATION OF COLOMBIA

Higher education and specialized research centers have played crucial roles in scientific and technological development in the advanced nations. The central proposition presented here is that centers of higher education (and research institutes) are also are assuming a crucial function in the process of scientific and technological development in Colombia. Because of the relatively underdeveloped knowledge sector, their activities are of great importance in adapting to worldwide pressures for change. They act as centers for research, innovation, training, professional services, as well as centers for generating change proposals.

In developing countries, higher education has also undergone a vast expansion during the last thirty years. This has occurred with the expectation of preparing professionals for managerial and technical roles in society, fulfilling a growing level of expectations for mobility of the population at large, and supporting the development of the state apparatus. Higher education systems have been constructed largely, at least in appearance, on the advanced western country models (Altbach, 1982). The training often involves the incorporation of the "latest" in techniques, methods and issues drawn from advanced industrialized nations. This has meant, among other

things, the wholesale incorporation of curriculum programs, translations of textbooks, and educational innovations (especially educational technology).

In the 1960's and 1970's there was a large growth in the social sciences and more traditional fields of humanities and law[9]. The latest wave of higher educational expansion has involved a growing emphasis upon training in areas central to technocratic management (especially all forms of engineering, computer science, and management) as well as the physical science (e.g., biology, chemistry, etc.). These are areas which supposedly generate human capital with higher levels of productivity and more relevant to the specific needs which countries are facing. There is also a growing emphasis upon the efficient management of education at all levels in order to attain cost reductions and hence increase the "returns to education", as viewed by human capital theorists. Distance education programs have become attractive as policy options in this regard.

Higher education, then, has had to innovate to sustain and evolve its own role as a leading edge sector within societies undergoing rapid change. The informatics sector has been proving itself to be a vital source for this process of institutional renewal. The central proposition which can be put forward here is that this shift in emphasis of higher education reflects a broader trend within society towards the growing importance of technocratic management with scientific and technological development as the underlying method and instrumentality.

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9 This emphasis has come under increasing scrutiny. Criticisms range from the excessive resources being invested (e.g., as in comparison with primary or secondary education) , the inability of economic growth to keep pace with the outflow of higher education graduates, a disparity between a growth of credentialism and growth in real productivity, the wholesale importation of curriculum content and methods of solving problems inappropriate to local needs, etc.

I have chosen to focus upon the ways in which innovation in higher education and university-like research centers interact with "scientific and technological innovation" in society at large. The three central concerns which future research should address are: What has been the extent and nature of the involvement of universities and "specialized research centers" in the process of informatization of Colombian society? Second, what has been the impact of this intervention upon the informatization process? And third, what implications may we infer from this process as to the role of the university in the broader relationship between scientific and technological development and national development strategies? Central to this analysis is the widely discussed model of centers of higher education in triangular interaction with the state and industry (Sabato/Botana,, 1970).

From the Colombian experience, there are a multitude of specific "cases" which may can be drawn upon as the basis for such an analysis. These include the role of higher education and research centers in incorporating informatics technologies into a series of "socio-institutional sub-systems", including: higher education itself; the state apparatus; the primary and secondary school system; and industry.

The Matrix in Figure 4 illustrates the ways in which the sector specific case studies relate to three functional roles of the university: carrying out "basic or applied"research, applying scientific knowledge and technique to policy-making arenas[10], and training human resources (e.g., managers, technical personnel and teachers). In Colombia, a select group of universities

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10 This is of either of the social experimentation type or of the consultancy service type.

Figure 4. Linkages Between Innovation in Higher Education and National Informatics Development

	HIGHER EDUCATION/ RESEARCH CENTERS	STATE APPARATUS	PRIMARY AND SECONDARY SCHOOLING	INDUSTRY	OTHER ISSUES
BASIC OR APPLIED RESEARCH	University of the Andes, CIFI research and consulting center Instituto Ser, research and consulting center	———	· Educational microcomputer · Cognitive learning and educational software	Specialized research programs in: · robotics · numerical control · industrial engineering and computer technologies.	———
SCIENTIFIC KNOWLEDGE IN POLICY: · program design and experimentation	Design of Programs for Open and Distance Education	Policy studies : · Privacy · Educational microcomputer · Software protection	Social experiments and legimitation of educational innovations: "NEMOCON AND MICRO-COMPUTERS IN THE SCHOOL"	———	———
· consultancy services	———	Univ Andes, Instituto Ser: Technical and organizational consultants to State Apparatus for systematization programs. Projects include most major ministries: · Education · Justice · Finance · Foreign Affairs · and Telecom	———	———	———
TRAINING OF HUMAN RESOURCES	Specialized training programs: · Higher education management and information systems	Specialized training programs: · public sector management information systems · telecommunications development · legal informatics Specialized policy-training in: · International software negotiations · International Negotiations for Science and Technology	Teacher training for use of educational technology: · Univ. Antonio Narino	Specialized training programs in · robotics · numerical control · industrial engineering and computer technologies.	International and national seminars and congresses

The Universities have worked in close relationship with:
- Coiciencias: The Colombian National Science Foundation
- ICFES: The Institute for the Development of Higher Education
- The Presidential Secretariat for Informatics
- DANE: The National Statistical Agency
- ACUC, ACIS and ACCIO: Professional and informatics industrial associations

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and research centers have played a pivotal role in this process of adapting, innovating and diffusing advanced methods of science and technology[11].

Basic or applied research: Various universities have formed research groups or research centers. They have been conducting basic or applied research in microcomputers and education, telecommunications, electronics, and applications of automation technologies to industrial processes.

Scientific Knowledge and Technique in Policy-Making: A few universities and research centers have been at the center of a significant part of the technocratic development of the state apparatus. The University of the Andes, through its young (approximately ten years) but highly influential technical research/consultancy arm (CIFI, Center for Investigations of the School of Engineering) has carried out the conceptualization, promotion, and partial implementation of many of the most significant systematization research projects within the state. The Instituto Ser has also played an increasingly important role over time. Many other universities have intervened in the Open and Distance Education Program, though few have added significant technological capabilities to the program. They have also supported the development and maintenance of the state promoted popular informatics resource centers. The "Nemocon rural-microcomputers" social experiments have been designed and orchestrated by a university like research center (Instituto Ser). And other universities have conducted research to develop a Colombian educational microcomputer proto-type. Universities have also helped in the design and implementation of "Open and Distance Education program" of the Betancur government (1982-1986). This

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11 The most important universities for scientific and technological development have been the University of the Andes, the National University of Colombia, the Industrial University of Santander, the University of Medellin, the University of Antioquia, and the University of Valle.

proposed to widen access to university study through the use of advanced technologies and training methods in distance education.

Training of Human Resources: The same group of universities, as well as a few others, have provided the training to state officials and industry personnel for the use of a wide range of technologies and methods, including: management information systems, telecommunications, software and technology negotiating, educational uses of microcomputers, industrial applications of information technology, etc.

From a political perspective, some of the more salient issues raised by the cross-sectoral process of informatization of Colombian society, and the role of institutes of higher education in the process, is suggested in the following section.

4. INTERPRETING THE COLOMBIAN EXPERIENCE: LEGITIMACY AND CONFLICT MANAGEMENT IN TECHNOLOGY POLICY

One approach to interpreting the significance of scientific and technological change and the role of higher education within this process comes from Weiler's (1983,1985, 1989a, 1989b) cross country studies on the politics of educational innovation and reform. In his 1985 work on educational innovation, he highlights a series of critical issues and broader theoretical implications. The issues are "...the relationship of innovation, knowledge and research [see also Weiler, 1989b]; the issue of legitimacy in educational innovations [see also Weiler, 1983]; and different interpretations of the conflictual nature of educational reform". The broader theoretical implications of these issues are on the development of "convergence theory .... [as] the gradual progression of industrialized structures toward a common social structure.....[and] the ever widening discussion on.... theories of the state

in the analysis of educational policies". *Weiler (1989a) also highlighted the* importance of decentral-ization in educational policy making.

The Colombian case experience offers multiple dimensions to inform these issues and theoretical domains. I will respond, at this time, by referring to two specific questions. First, how do scientific and technological programs contribute to legitimacy of the state? Second, what conflicts actually underlay the policy-making process and how are these conflicts managed?

Compensatory Legitimation

The inability of the state to fulfill the overload of expectations with which it is confronted (Weiler, 1983) generates the need for innovations, real or apparent, to help sustain even minimal levels of popular support. This is especially evident in the situation of crisis ridden developing countries.

Because of the drive to "feel modern", and the expectation of the population to "reap the benefits" of modernization, innovations which capture the spirit of modernness are attractive as "images" with social salience (recall Bolter, p. 1). The use of this symbol of progress as a strategy of compensatory legitimation can be illustrated on two accounts. First, governments generate policies and programs which portend to "transfer" informatics access as benefits to the population. During the Betancur government (1982-1986), the Presidency itself opened up ten popular centers for informatics access to the population (Colciencias, 1988). During the last four years a series of "social scientific experiments"[12] have been undertaken with Colombian peasants to determine the benefits of incorporating microcomputers into rural

12 See Qvotrup (1987) for the diverse types of "social experiments" which have been undertaken with advanced technologies; see Weiler (1983) for the role of scientific experimentation as legitimation.

schools, the Nemocon Project (Colciencias, 1988). This has been touted as an an implicit precursor to some program of massification of microcomputers into the rural and urban primary school system. These programs have been the subject of massive and continual publicity to the population at large, with the mass media playing an important role.

Second, governments need to demonstrate, that they are improving their capabilities to "manage the affairs of the nation" so-to speak. This involves improving the efficiency of the bureaucracy, providing better services, cutting costs, and eventually holding taxes even or reducing them. Again, the new technologies have offered innumerable promises in this regard (Finlay, 1987). In Colombia, the language of technical progress has increasingly become a mainstay of political pronouncements. "Information systems, automation and administrative modernization" have become the new indicators that the bureaucracy has developed. There is hardly a ministry or important governmental agency in the country[13] which has not and continues to tout the advances they are making on these front to convince the public that things will soon get better.

Conflicts and Conflict Management

Any process of scientific and technological change which modifies the social relations of production or of governance has embedded within it the seeds of conflict. We are concerned then with two aspects: the relationship between the existing disparities of knowledge and the struggle for power over the control and use of these technologies; and the conflicts over internal

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13 At the National level. he institutions with known major systematization or automation programs include: Ministries of Taxes and Public Finance, Education, Development, Justice, and Communications; the Presidency itself; and the tens of sub agencies. At the local level, city administrations and public enterprises are undergoing similar processes.

issues of the programs themselves (i.e., costs, timetables, financing, suppliers, actors, etc.)

Scientific and technological development is knowledge intensive. This knowledge is also produced and distributed in many forms, from the sophisticated software which programs the systems, to the construction and maintenance of the physical systems, to the managerial and procedural methods to incorporate the technologies within social institutions. These forms of knowledge have and continue to be defined within the structure of center-periphery relations which are resistant to rapid modification.

Center	Periphery
- advanced countries	developing countries
- urban centers	rural zones
- elite universities	"popular universities"
- multinationals, monopolistic firms	national enterprises small and medium scale enterprises
- elites	the common citizen
- national bureaucracy	local bureaucracy
- entrenched political parties	participative movements and alternative political parties

Conflict over the control of informatics technologies can be delineated by the struggle over the control of knowledge between these opposing poles of interests.

The expansion of these technologies influences the structure of control through modification of the flows of information, the functions which different "technocrats" assume within organizations, and increasingly

through the structuring of logical ("intelligent") decision procedures (Feigenbaum, 1983, 1988) which drive organizational outcomes[14] . They therefore become central elements in the re-constitution of organizational logic (at the firm level) and institutional re-composition at the national level (Mattelart, 1983; Mercier, 1984; Schiller, 1981).

At the governmental level in Colombia, these technologies are at the center of most institutional plans of restructuring which are moreover linked to global plans for national change. The massive process of administrative, financial and political decentralization which Colombia is currently undergoing involves institutionally restructuring the activities of much of the previously centralized state bureaucracy, as well as the creation of local interconnected units of governance. Mattelart (1983) argues that informatics technologies are the tool by excellence to maintain centralization in key decision making while giving the appearance of more local autonomy. Weiler (1989a) also argues that many of the plans for "decentralization" in education are much less oriented towards developing true autonomy and participation, than they are symbols of political discourse and means to reconstitute existing hierarchies. These technologies are incorporated under the banner of rationalization and efficiency.

A case in point is the Ministry of Justice of Colombia which is currently among the most crisis ridden institutions in Colombian society [15]. Informatics technologies together with administrative "modernization" have

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14 An extremely simple logical "intelligent" decision procedure would be: "If client is 'delinquent' on payments, send to credit control agency".

15 It is under attack from all sides (drug lords, leftist guerrillas, common delinquency, machinations of political elites). Literally hundreds of thousands of cases are backlogged, the judicial apparatus is ineffective, and any efforts to bring to trial the more important cases face the threat and actual recourse to violence.

been used as key symbols of actions being taken. In practice, the efforts have been largely ineffectual to date.

A similar set of issues emerge at the international level over the control of knowledge, between multinationals and foreign governments at one end and national enterprises and developing country state apparatuses on the other (Dedijer/Jequier, 1987). In the private sector, there is also the potential for conflicts between management and workers with processes of automation; as their is between monopolization of large enterprises achieving economies of scale with advanced technologies and medium and smaller enterprises who often cannot compete.

A second set of conflicts center more around the internal logic of the projects themselves, and involve such issues as: How much should be spent on these technologies? Who should be the suppliers of the hardware? What groups or institutions should be given the authority to develop the integrated systems? (In many cases this involves significant contracts for software development and management consulting.) Within what time frame should these projects be carried out? Should massive investments be made? What pilot projects or experiments need to be carried out to either "prove" the effectiveness of the systems or to legitimate the project? How should modular systems be integrated within the overall state apparatus? Who should be the primary or secondary users of the systems?

The many actors involved in the process of modernization include: foreign and national consultants, international and national financing agencies, foreign governments, multinational corporations and national enterprises, political elites and political opposition movements, governmental bureaucrats, national researchers and scientists, industrial and professional associations, etc. Strategies are formulated; alliances are formed; and

pressures are applied to move the projects in one direction or another (Benveniste, 1989). At stake are control over the projects, benefits to be accrued through contracts and/or corruption, user services, user and operator rights, and the future development or stagnation of national industries in the knowledge sector.

The important role which informatics technologies play within the process of compensatory legitimation and conflict management can only be suggested in this paper. It is clear though that it offers a promising approach to interpretation of the political and social significance of the use of technology as an instrument of power. Yet given the pressing need for instruments of real reform and modernization in developing countries such as Colombia, we are still left with the need of determining the extent to which these technologies are becoming "tools for progress" vs. "instruments of control".

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